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Fabrication Manual for a Reduced-Noise Auger Miner Cutting Head

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UNITED STATES DEPARTMENT OF THE INTERIOR

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UNIT OF MEASURE ABBREVIATIONS USED IN THIS REPORT

dBA	decibel (A-weighted network)
in	inch
min	minute

FABRICATION MANUAL FOR A REDUCED-NOISE AUGER MINER CUTTING HEAD

By Mark R. Pettitt[1] and William W. Aljoe[2]

ABSTRACT

After a long series of laboratory and in-mine tests, a cost-effective, mineworthy, reduced-noise auger miner cutting head was designed, fabricated, and field-tested by Wyle Laboratories under contract to the Bureau of Mines. Compared with standard auger cutting heads, the new heads reduced noise by 10 dBA at the jacksetter's position and by 6 dBA at the operator's position. This report contains detailed fabrication instructions, including engineering drawings, that show how a standard auger cutting head can be modified to produce a reduced-noise auger.

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INTRODUCTION

Auger-type continuous miners are designed to extract coal from thin seams, approximately 26 to 50 in high. Figure 1 shows one model of auger miner, the Fairchild (Wilcox) Mark 21. The two rotating augers at the front of the miner cut the coal and move it to the chain conveyor at the center of the machine. The conveyor carries the coal to the rear of the machine and dumps it onto a bridge conveyor system. The bridge conveyor connects with a panel conveyor (panline), which removes the coal from the face area.

Figure 2 describes the cutting pattern of the auger-type continuous miner. Note in figure 2 that the anchor jack is placed very close to the face before each arc-shaped cut is made. On the Mark 21 miner in figure 1, the hydraulic anchor jacks are emplaced remotely by the machine operator. However, on the older Mark 20 auger miner, the anchor jacks are simple mechanical posts, emplaced manually by workers called jacksetters. In addition, both models of auger miners require the presence of timbermen and/or cleanup men in the immediate face area. Because of their close proximity to the cutting heads, the jacksetters, timbermen, and cleanup men on auger mining sections are exposed to more noise than almost all other workers in underground coal mines.

Typical noise levels during coal cutting are approximately 108 dBA at the jacksetter's position and 102 dBA at the

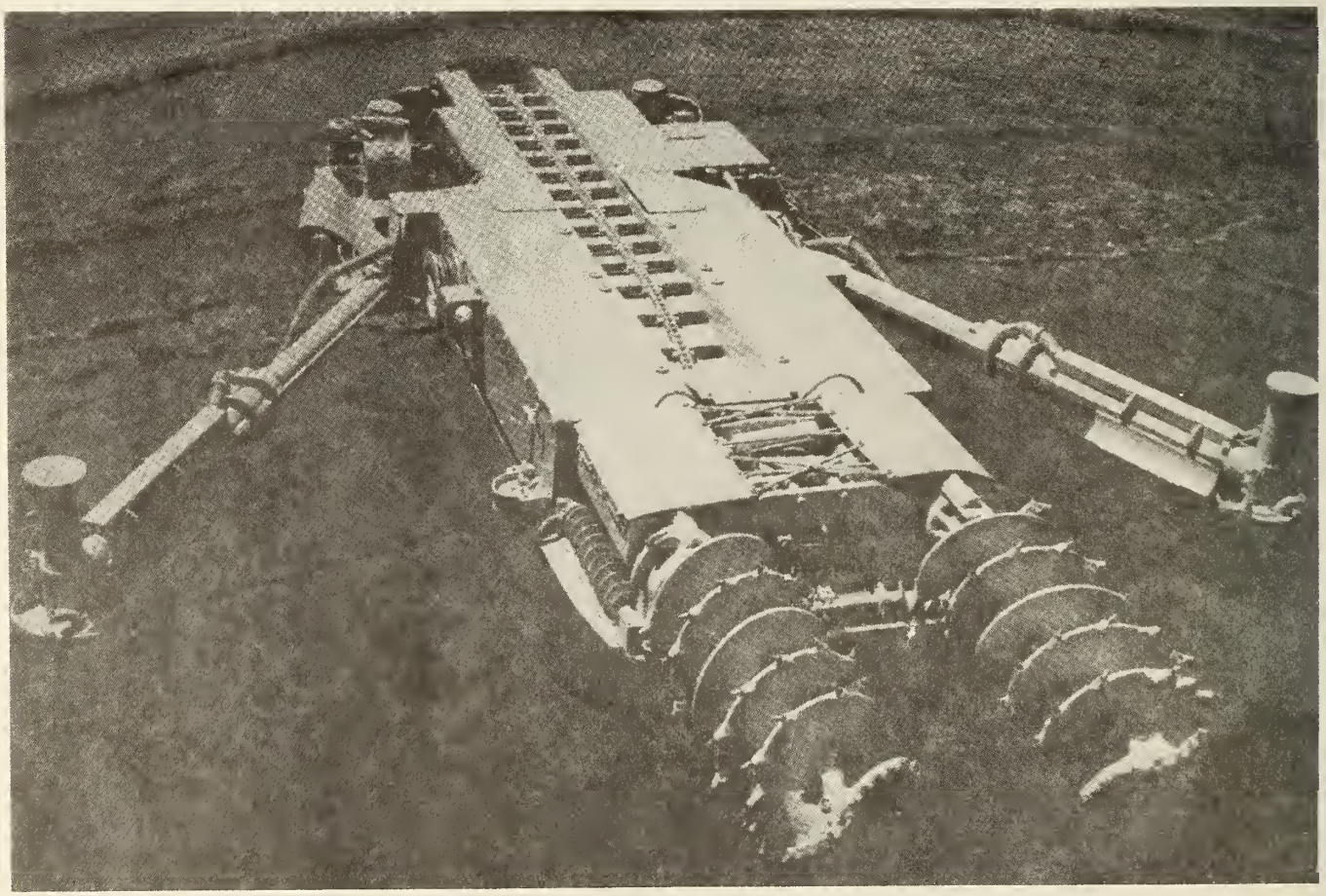
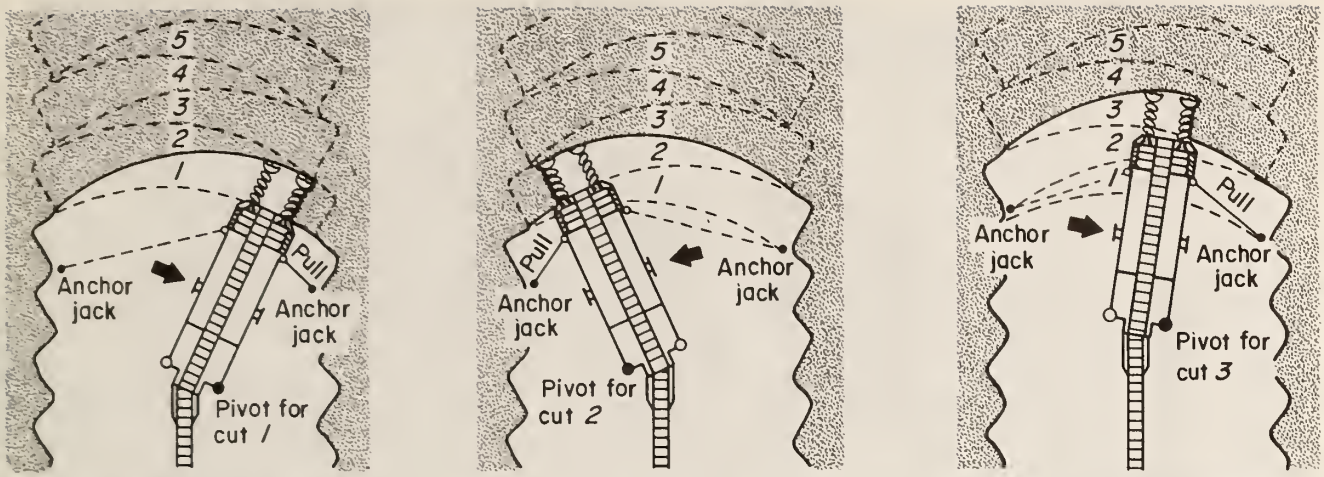


FIGURE 1. - Overall view of standard auger-type continuous miner.



A Miner pivots on extended right pivot jack as it swings to right making cut *1*. Retracted left pivot jack swings forward toward cut *2* pivot point.

B Pivoting on extended left pivot jack, miner swings to left through cut *2*. Retracted right pivot jack advances toward cut *3* pivot point.

C Again pivoting on extended right pivot jack, miner swings right, making cut *3*. Retracted left pivot jack moves ahead toward cut *4* pivot point.

FIGURE 2. - Cutting sequence of auger-type continuous miner.

operator's station.[3] Because MSHA noise regulations allow only 45 to 90 min of exposure per shift at these levels, jacksetters and machine operators are often out of compliance.

Although the chain conveyors and drive motors of auger-type continuous miners are significant noise sources, coal cutting is by far the dominant noise source. To investigate and control coal cutting noise, the Bureau of Mines awarded a research contract to Wyle Laboratories, Huntsville, AL.[4] Under this contract, a new pair of auger cutting heads were designed, fabricated, and tested extensively in an underground coal mine. Compared with standard (Wilcox) cutting heads, these simple, rugged new heads reduced noise by 10 dBA at the jacksetter's position and by 6 dBA at the operator's position. The in-mine tests showed that the reduced-noise heads cut as well, loaded as fast, and lasted as long as the standard heads.

This manual describes how the standard auger cutting head can be modified in almost any weld shop to produce the reduced-noise head. Design details vary for different auger sizes; however, the same three design concepts are employed:

1. The helixes of the standard auger cutting head (fig. 3) vibrate violently during coal cutting and are the primary sources of coal cutting noise. However, underground tests have shown that only one helix is needed on the auger for effective cutting, loading, and cleanup. Because the new auger cutting head has only one helix, versus two on the standard auger, less metal vibrates and less noise is generated. Closely spaced bits on this single helix smooth out the cutting forces applied to the head.

2. The single helix is stiffened by increasing the auger's core size and applying a conical helix stiffener. The higher the helix, the more it vibrates;

[3]Bobick, T. G., and D. A. Giardino. The Noise Environment of the Underground Coal Mine. MESA IR 1034, 1976, 26 pp.

[4]Pettitt, M. Development of a Reduced-Noise Auger Miner Cutting Head (BuMines Contract H0188065). Final Report. March 1983, 200 pp.; available for consultation at Pittsburgh Research Center, Bureau of Mines, Pittsburgh, PA.

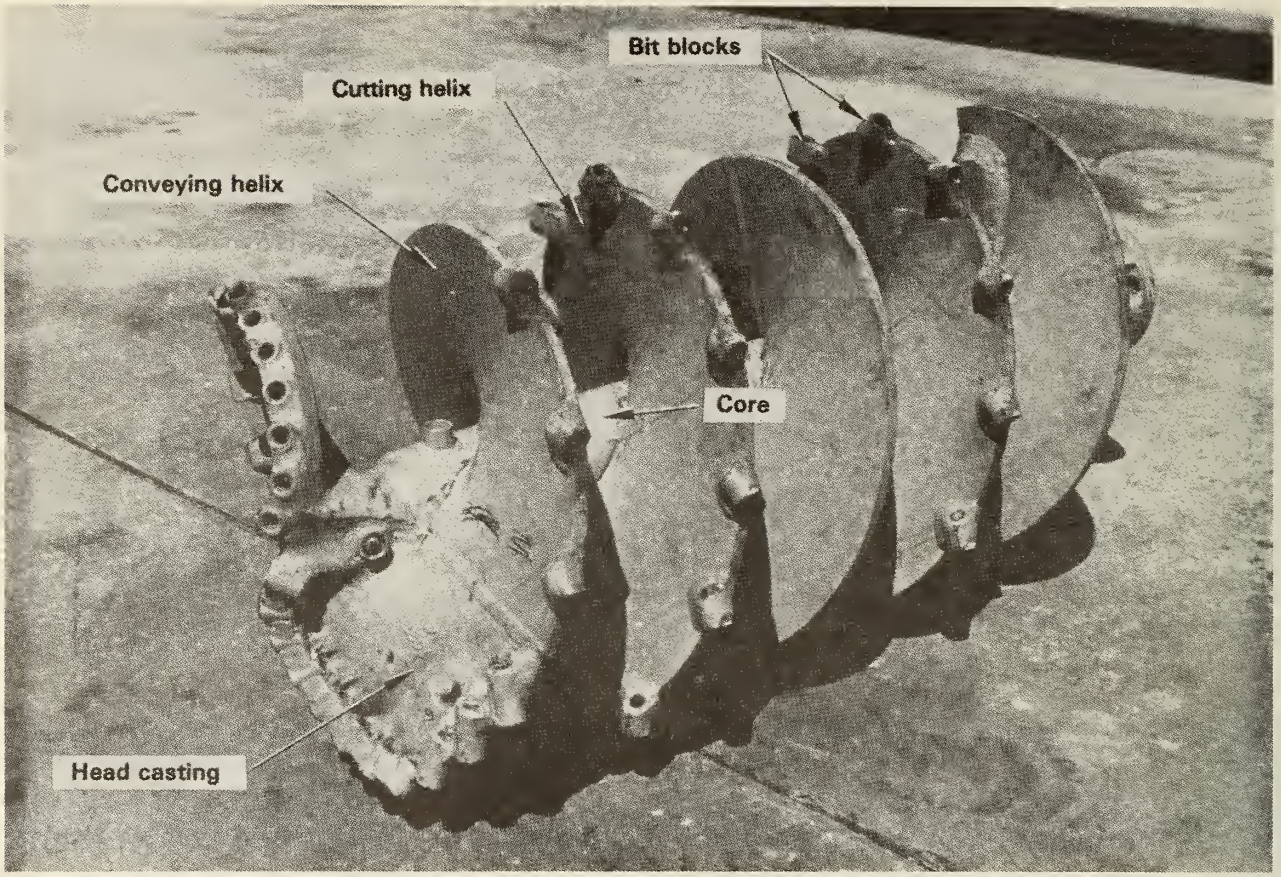


FIGURE 3. - Standard auger miner cutting head.

therefore, the core of a 28- or 32-in-diam auger can be enlarged to stiffen the helix and reduce its vibration. The conical helix stiffener is a second helix, leaned against and welded solidly to the cutting helix. It forms a continuous support for the cutting helix and greatly increases its stiffness, thus reducing vibration even further. More than one-half of the noise reduction achieved with the new auger cutting head results from the stiffer helix.

3. The conical, triangular cavity between the helix stiffener and the bit-carrying helix is filled with sand and sealed. The sand adds mass, which reduces the response of the helix to cutting impacts and helps dissipate its bell-like "ringing" vibration. Almost one-half of the noise reduction achieved with the new cutting head is due to the sand.

FABRICATION INSTRUCTIONS

Standard auger miner cutting heads (fig. 3) range from 22 to 32 in. in outside (helix) diameter. Ideally, the core diameter of the 28- and 32-in augers should be enlarged to achieve maximum noise reduction. Although figure 4 contains the details of this modification, it is a difficult process that should not be attempted by most mine shops. Nevertheless, significant noise reductions can be achieved by adding only the conical helix stiffener and sand. This is a relatively simple process, as described below.

STEP 1. - REMOVE HELIX AND RELOCATE BITES

Remove the bit-carrying helix, starting 30° from where the helix attaches to the head casting (fig. 3). Weld new bit

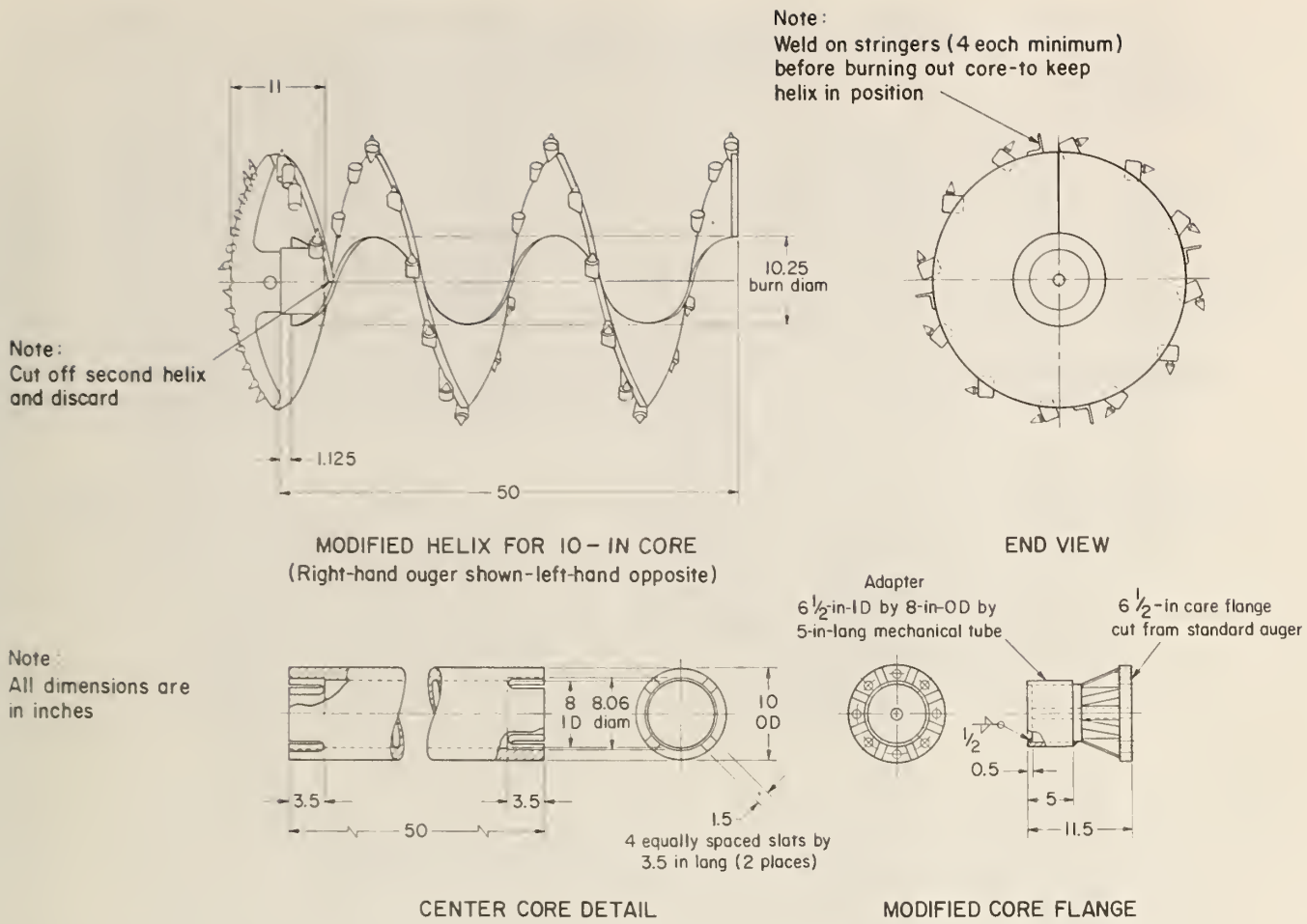


FIGURE 4. - Large-core fabrication details.

holders onto the remaining helix at 30° intervals as shown in figure 5.

STEP 2. - PREPARE STIFFENER SEGMENTS

Using the dimensions in the table in figure 6, fabricate the stiffener segments from 3/8-in-thick plate. If adequate metal rolling facilities are available, 180° segments (two per revolution) can be prepared. Otherwise, the stiffener should be cut into 30° segments (12 per revolution).

STEP 3. - WELD STIFFENER SEGMENTS TO AUGER

Attach the stiffener segments as shown in figures 6, 7, and 8. The size of the segment and dimension B in figure 6 determine the angle the stiffener should

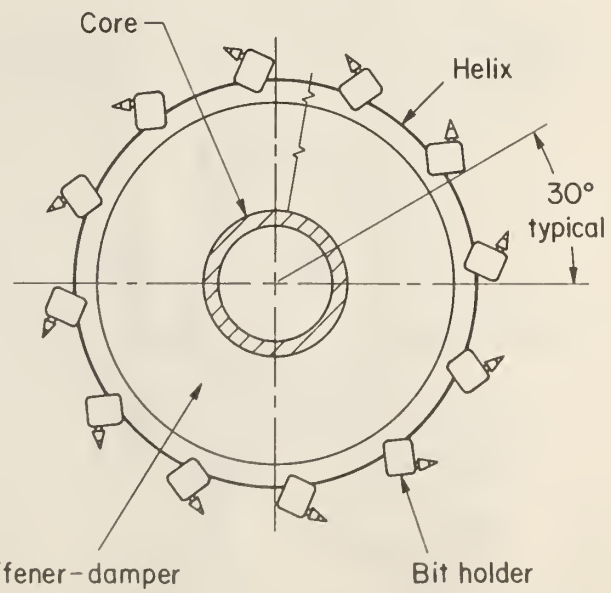
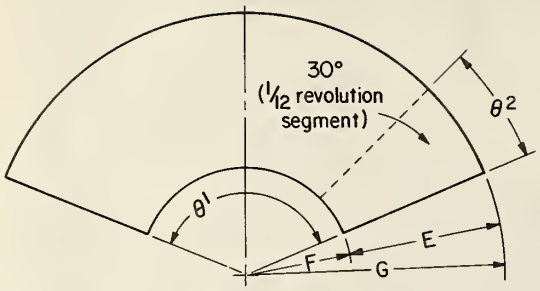


FIGURE 5. - Bit spacing pattern on modified auger.



Flat pattern for 180° segment, 3/8-in plate

Auger cutting diameter, in	Dimensions, in							Angle		
	A	B	C	D/2	E	F	G	θ^1	θ^2	θ^3
SMALL CORE (6.5-IN DIAM)										
22	6.5	5.75	4.42	9.0	7.25	6.60	13.85	124.2°	20.7°	37.5°
24	6.5	6.75	4.29	10.0	8.00	6.12	14.12	134.0°	22.3°	32.5°
26	6.5	6.75	4.29	10.0	8.00	6.12	14.12	134.0°	22.3°	30.55°
28	6.5	7.75	4.57	11.0	9.00	5.93	14.93	137.6°	22.9°	28.95°
30	6.5	8.75	4.84	12.0	10.00	5.78	15.78	141.84°	23.6°	28.95°
32	6.5	9.75	5.09	13.0	11.00	5.64	16.64	144.89°	24.15°	27.58°
LARGE CORE (10-IN DIAM)										
26	10.0	6.00	4.50	11.0	7.50	8.05	15.55	132.8°	22.13°	36.9°
28	10.0	7.00	4.60	12.0	8.38	7.65	16.03	139.7°	23.28°	33.3°
30	10.0	8.00	4.64	13.0	9.25	7.35	16.60	145.4°	24.23°	30.1°
32	10.0	9.00	4.90	14.0	10.25	7.21	17.46	148.3°	24.72°	30.1°

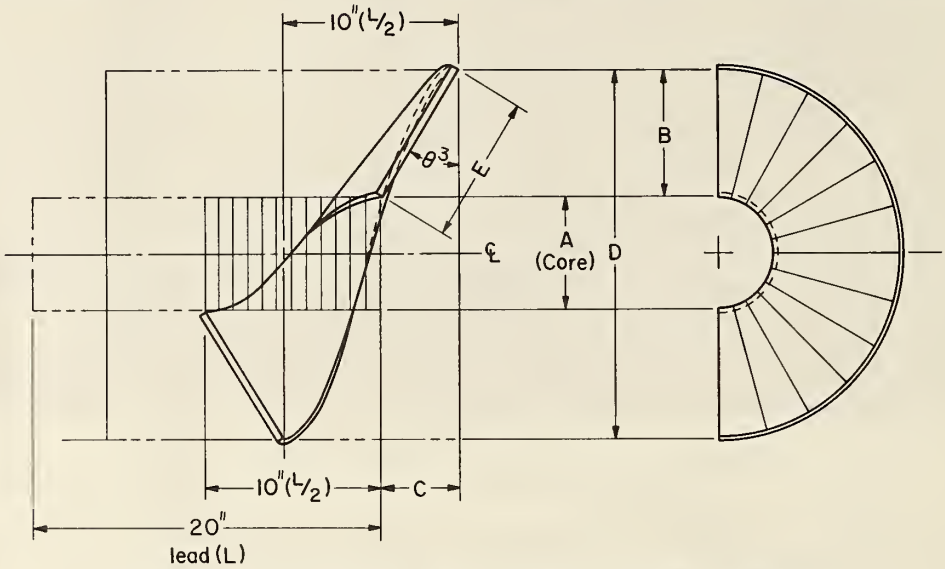


FIGURE 6. - Fabrication details of helix stiffener segments.

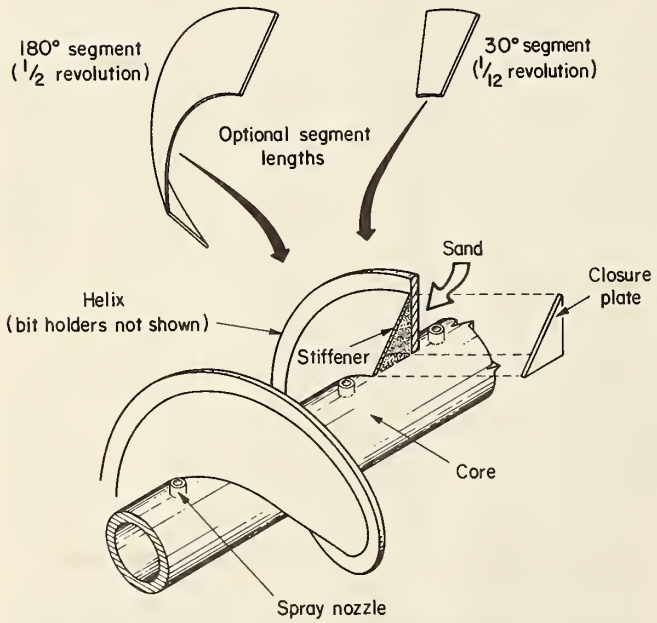


FIGURE 7. - Installation of stiffener segments on auger.

make with the helix. As detailed in figure 8, three separate cavities are formed by the stiffeners. The largest cavity is on the inby (nonconveying) side of the helix, beginning at the rear end and extending forward; it ends one-fourth revolution from the start of the head casting. The next largest cavity begins at the same location, but on the outby (conveying) side of the helix, and continues forward to the end of the head casting. The smallest cavity is also on the outby (conveying) side of the helix and covers the remaining section of the head casting. Any spray nozzles interfering with the installation of stiffener segments should be removed, sealed, and relocated. All welds for attaching the segments to the core, helix, and adjacent segments must be continuous to form a completely

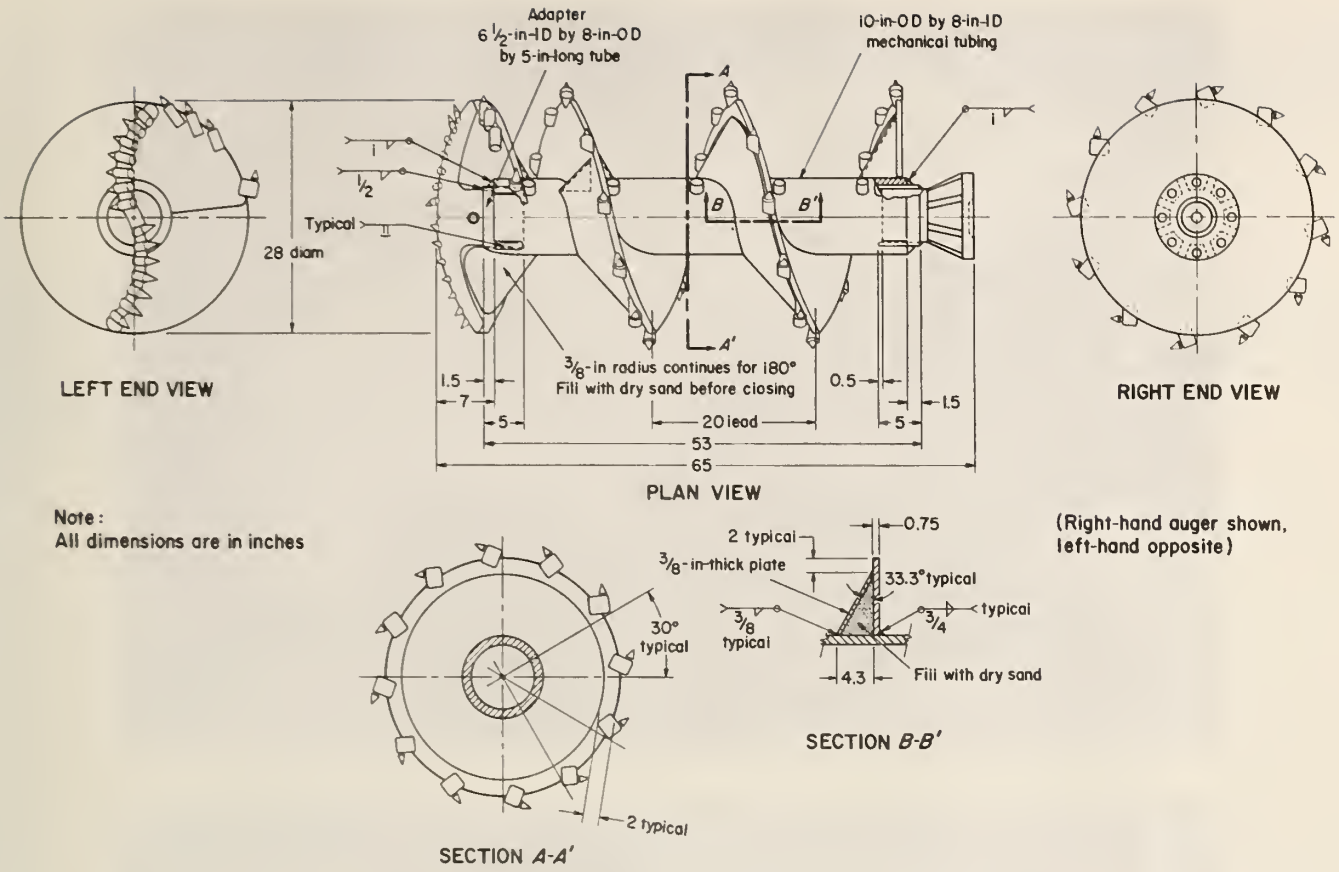


FIGURE 8. - Fabrication details of reduced-noise auger.

closed cavity for the sand, which will be added in the next step. Proper formation of these cavities, with the plates at the correct angles, is the key to a successful modification.

STEP 4. - FILL CAVITIES WITH SAND

Seal the inby ends of all three cavities with closure plates as shown in figure 7; then, as shown in figure 9, stand the modified auger in a vertical position, with the head casting down. Fill the three cavities with *dry* silicone sand, and vibrate the auger periodically during filling to compact the sand; a welder's chipping tool is sufficient for this purpose. When filling is completed, install closure plates on the outby ends of each cavity (fig. 9).

STEP 5. - REPAINT THE CUTTING HEAD

Figure 10 shows the reduced-noise auger after the completion of modifications,

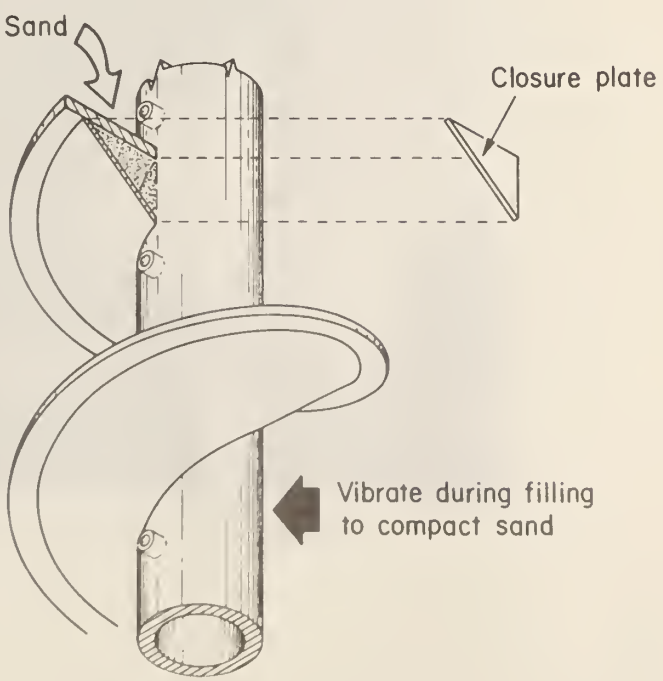


FIGURE 9. - Addition of sand to cavities.

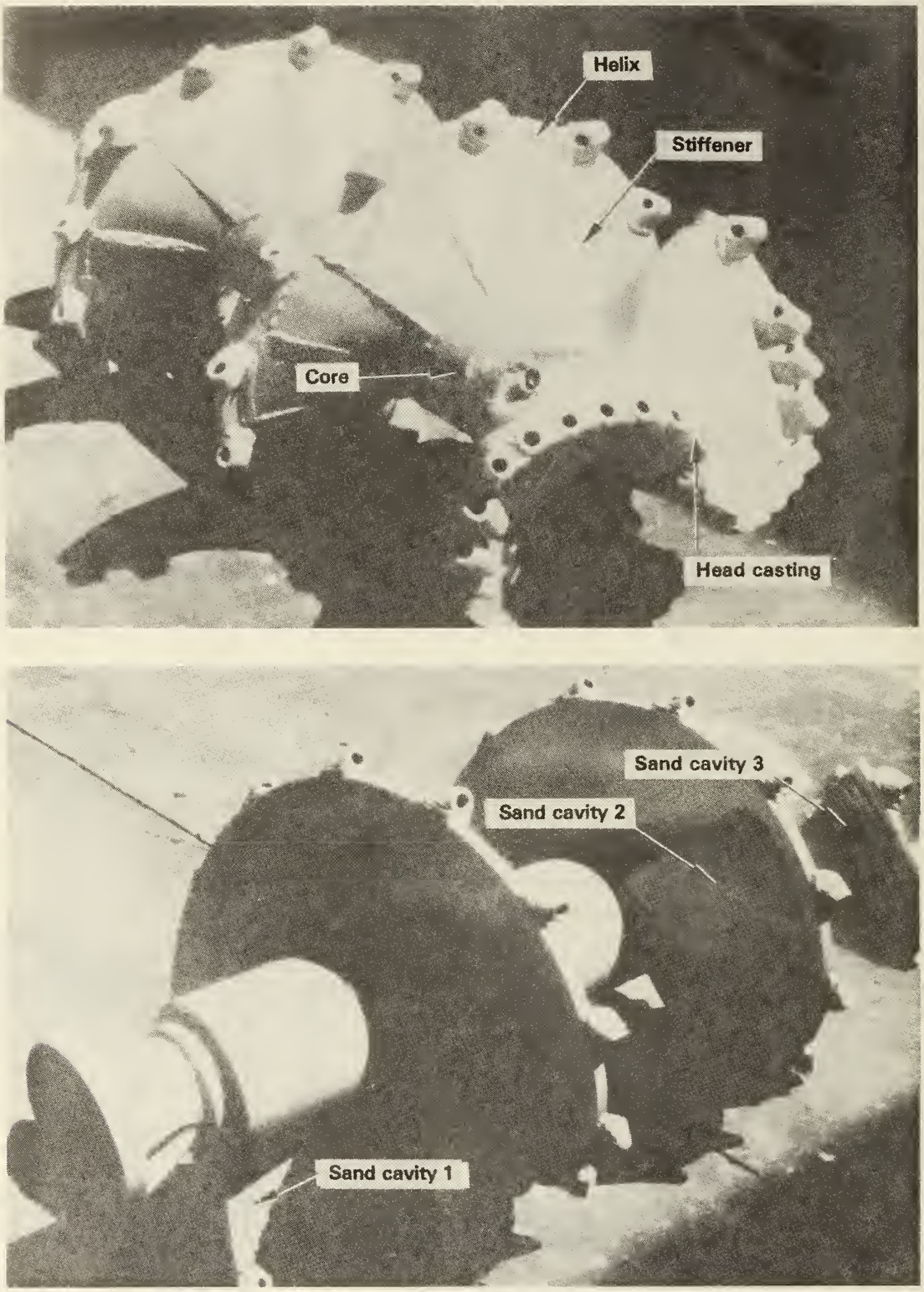


FIGURE 10. - Front and rear views of reduced-noise auger.

including repainting. The top photograph shows the inby side of the auger and its major components. The bottom photograph shows the outby (conveying) side of the auger; the locations of the three sand cavities described in step 3 can be seen here. Figure 10 should be used in conjunction with figure 8 to determine the proper final configuration of the modified auger.

CONCLUSIONS

Bureau-sponsored research has shown that the noise produced by a standard auger miner cutting head can be reduced by about 6 to 10 dBA through modifications to the auger helix. By following the instructions in this manual, any mine shop can convert a standard auger into a reduced-noise auger. In-mine tests have shown that the reduced-noise auger cuts as well, loads as fast, and lasts as long as the standard cutting head.

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